Section 6.3

Check Your Understanding, page 389:

1. Check the BINS: Binary? "Success" = get an ace. "Failure" = don't get an ace. Independent? Because you are replacing the card in the deck and shuffling each time, the result of one trial does not tell you anything about the outcome of any other trial. Number? The number of trials is set at $n = 10$ in advance. Success? The probability of success is $p = \frac{4}{52}$ for each trial. This is a binomial setting. Because X counts the number of successes, it is a binomial random variable with $n = 10$ and $p = \frac{4}{52}$.
2. Check the BINS: Binary? "Success" = over 6 feet. "Failure" = not over 6 feet. Independent? Because we are selecting without replacement from a small number of students, the observations are not independent. Number? The number of trials is set to $n = 3$ in advance. Success? The probability of success will not change from trial to trial. Because the trials are not independent, this is not a binomial setting.
3. Check the BINS: Binary? "Success" = roll a 5. "Failure" = don't roll a 5. Independent? Because you are rolling a die, the outcome of any one trial does not tell you anything about the outcome of any other trial. Number? The number of trials is set to $n = 100$ in advance. Success? No. The probability of success changes when the corner of the die is chipped off.

Check Your Understanding, page 397:

1. Check the BINS: Binary? "Success" = question answered correctly. "Failure" = question not answered correctly. Independent? The computer randomly assigned correct answers to the questions, so knowing the result of one trial (question) should not tell you anything about the result on any other trial. Number? There were $n = 10$ questions. Success? The probability of success is $p = 0.20$ for each trial. This is a binomial setting. Because X counts the number of successes, it is a binomial random variable with $n = 10$ and $p = 0.20$.
2. $P(X = 3) = \binom{10}{3}(0.2)^3(0.8)^7 = 0.2013$. There is a 20% chance that Patti will answer exactly 3 questions correctly.
3. $P(X \geq 6) = 1 - P(X < 6) = 1 - P(X \leq 5)$ = 1 – binomcdf(trials:10, p: 0.2, x value:5) = 1 – 0.9936 = 0.0064. There is only a 0.0064 probability that a student would get 6 or more correct, so we would be quite surprised if Patti was able to pass.

Check Your Understanding, page 400:

1. $\mu_X = np = 10(0.20) = 2$. If many students took the quiz, we would expect students to get about 2 answers correct, on average.
2. $\sigma_X = \sqrt{np(1-p)} = \sqrt{10(0.20)(0.80)} = 1.265$. If many students took the quiz, we would expect individual students' scores to typically vary from the mean of 2 correct answers by about 1.265 correct answers.
3. Two standard deviations above the mean is $2 + 2(1.265) = 4.53$. Because Patti's score must be an integer, we are asked to find $P(X \geq 5) = 1 - P(X \leq 4)$ = 1 – binomcdf(trials:10, p:0.2, x value:4) = 1 – 0.9672 = 0.0328. There is a 0.0328 probability that Patti will score more than two standard deviations above the mean.

Check Your Understanding, page 408:

1. Die rolls are independent, the probability of getting doubles is the same on each roll (1/6), and we are repeating the chance process until we get a success (doubles). This is a geometric setting and T is a geometric random variable with $p = \frac{1}{6}$.

2. $P(T = 3) = \left(\frac{5}{6}\right)^2 \left(\frac{1}{6}\right) = 0.1157$. There is a 0.1157 probability that you will get the first set of doubles on the third roll of the dice.

3. $P(T \le 3) = P(T = 1) + P(T = 2) + P(T = 3) = \frac{1}{6} + \left(\frac{5}{6}\right)\left(\frac{1}{6}\right) + \left(\frac{5}{6}\right)^2 \left(\frac{1}{6}\right) = 0.4213$. There is a 0.4213 probability of getting doubles in three or fewer rolls.

Exercises, page 410:

6.69 Binary? "Success" = seed germinates and "Failure" = seed does not germinate. Independent? Yes, because the seeds were randomly selected, knowing the outcome of one seed shouldn't tell us anything about the outcomes of other seeds. Number? $n = 20$ seeds. Success? The probability that each seed germinates is $p = 0.85$. This is a binomial setting and X has a binomial distribution with $n = 20$ and $p = 0.85$.

6.70 Binary? "Success" = name has more than 6 letters and "Failure" = name has 6 letters or less. Independent? Because we are selecting without replacement from a small number of students, the observations are not independent. Number? $n = 4$ names are drawn. Success? The probability that a randomly chosen student's name has more than 6 letters is constant. Because the observations are not independent, this is a not binomial setting and Y would not have a binomial distribution.

6.71 Binary? "Success" = person is left-handed and "Failure" = person is right-handed. Independent? Because students are selected randomly, their handedness is independent. Number? There is not a fixed number of trials for this chance process because you continue until you find a left-handed student. Success? The probability that each student is left handed is $p = 0.10$. Because the number of trials is not fixed, this is not a binomial setting and V is not a binomial random variable.

6.72 Binary? "Success" = train is late and "Failure" = train is on time. Independent? Because the days were randomly selected, the arrival times are independent. Number? $n = 6$ days are selected. Success? The probability of arriving late is $p = 0.10$. This is a binomial setting and W has a binomial distribution with $n = 6$ and $p = 0.10$.

6.73 (a) This is the binomial setting. We check the BINS. Binary? "Success" = reaching a live person and "Failure" = any other outcome. Independent? Knowing whether or not one call was completed tells us nothing about the outcome on any other call. Number? We have a fixed number of observations ($n = 15$). Success? Each randomly-dialed number has probability $p = 0.2$ of reaching a live person.
(b) This is not a binomial setting because there are not a fixed Number of attempts. The Binary, Independent, and Success conditions are satisfied, however, as in part (a).

6.74 (a) A binomial distribution is *not* an appropriate choice for field goals made by the National Football League player, because given the different situations the kicker faces, his probability of

success is likely to change from one attempt to another (the Success condition is not met). However, the other three conditions are met: Binary? "Success" = making the field goal and "Failure" = missing the field goal. Independent? It is reasonable to think that the outcomes of field goal attempts are independent. Number? There are $n = 20$ attempts.
(b) This is the binomial setting. We check the BINS. Binary? "Success" = making a free throw and "Failure" = missing a free throw. Independent? It is reasonable to believe that each shot is independent of the others. Number? We have a fixed number of observations ($n = 150$). Success? Each shot has probability $p = 0.8$ of being made.

6.75 X = number of elk who survive to adulthood has a binomial distribution with $n = 7$ and $p = 0.44$. $P(X=4)=\binom{7}{4}(0.44)^4(0.56)^3 = 0.2304$. There is a 0.2304 probability that exactly 4 of the 7 elk survive to adulthood.

6.76 Y = number of plants that die before producing any rhubarb has a binomial distribution with $n = 10$ and $p = 0.05$. $P(Y=1)=\binom{10}{1}(0.05)(0.95)^9 = 0.3151$. There is a 0.3151 probability that exactly one of the 10 rhubarb plants will die before producing any rhubarb.

6.77 X = number of elk who survive to adulthood has a binomial distribution with $n = 7$ and $p = 0.44$. $P(X>4)=P(X=5)+P(X=6)+P(X=7)=\binom{7}{5}(0.44)^5(0.56)^2+\cdots = 0.1402$. *Using technology*: $P(X>4)=1-P(X\le 4)$= 1 – binomcdf(trials: 7, p: 0.44, x value:4) = 1 – 0.8598 = 0.1402. Because this probability isn't very small, it is not surprising for more than 4 elk to survive to adulthood.

6.78 Y = number of plants that die before producing any rhubarb has a binomial distribution with $n = 10$ and $p = 0.05$.

$P(Y\ge 3)=P(X=3)+P(X=4)+\cdots P(X=10)=\binom{10}{3}(0.05)^3(0.95)^7+\cdots = 0.0115$.

Using technology: $P(Y\ge 3)=1-P(Y\le 2)$= 1 – binomcdf(trials: 10, p: 0.05, x value: 2) = 1 – 0.9885 = 0.0115. Because this is a small probability, it would be surprising if three of more of the plants die before producing any rhubarb.

6.79 (a) Let X = the number of seeds that germinate. X has a binomial distribution with $n = 20$ and $p = 0.85$. $P(X=17)=\binom{20}{17}(0.85)^{17}(0.15)^3 = 0.2428$. *Using technology*: binompdf(trials: 20, p: 0.85, x value: 17) = 0.2428. There is a 0.2428 probability that exactly 17 seeds germinate.
(b) $P(X \le 12) = \binom{20}{0}(0.85)^0(0.15)^{20}+\cdots+\binom{20}{12}(0.85)^{12}(0.15)^8 = 0.0059$. *Using technology*: binomcdf(trials: 20, p: 0.85, x value: 12) = 0.0059. Because this is such a low probability, Judy should be suspicious. Having only 12 or fewer seeds germinate is unlikely to happen by chance alone.

6.80 (a) W = number of times the train is late has a binomial distribution with n = 6 and p = 0.10. $P(W=2)=\binom{6}{2}(0.10)^2(0.90)^4=0.0984$. *Using technology*: binompdf(trials: 6, p: 0.10, x value: 2) = 0.0984.

(b) $P(W \geq 2)=P(W=2)+\cdots+P(X=6)=\binom{6}{2}(0.10)^2(0.90)^4+\cdots=0.1143$. *Using technology*: 1 – binomcdf(trials: 6, p: 0.10, x value: 1) = 1 – 0.8857 = 0.1143. Because this probability is not very small, it would not be surprising if the train arrived late 2 or more times.

6.81 (a) $\mu_X = np = 15(0.20) = 3$. If we watched the machine make many sets of 15 calls, we would expect about 3 calls to reach a live person, on average.

(b) $\sigma_X=\sqrt{np(1-p)}=\sqrt{15(0.20)(0.80)}=1.55$. If we watched the machine make many sets of 15 calls, we would expect the number of calls that reach a live person to typically vary by about 1.55 from the mean (3).

6.82 (a) $\mu_X = np = 12(0.20) = 2.4$. If we tested many groups of 12 truthful applicants, we would expect about 2.4 people to be declared deceptive, on average.

(b) $\sigma_X=\sqrt{np(1-p)}=\sqrt{12(0.20)(0.80)}=1.39$. If we tested many groups of 12 truthful applicants, we would expect the number of people declared deceptive to typically vary by about 1.39 from the mean (2.4).

6.83 (a) Y is a binomial random variable with n = 15 and p = 0.80. Therefore, $\mu_Y = np = 15(0.80) = 12$. Notice that $\mu_X = 3$ and that $12 + 3 = 15$. In other words, if we reach an average of 3 live people in our 15 calls, we should expect to not reach a live person in an average of 12 calls.

(b) $\sigma_Y=\sqrt{np(1-p)}=\sqrt{15(0.80)(0.20)}=1.55$. This is the same value as σ_X. This makes sense because Y = 15 – X and adding (or subtracting) a constant to a random variable doesn't change the spread.

6.84 (a) Y is a binomial random variable with n = 12 and p = 0.80.

$P(Y \geq 10) = P(Y=10)+P(Y=11)+P(Y=12)=\binom{12}{10}(0.8)^{10}(0.2)^2+\binom{12}{11}(0.8)^{11}(0.2)^1+\binom{12}{12}(0.8)^{12}(0.2)^0$
$= 0.2835 + 0.2062 + 0.0687 = 0.5583$. Using technology: $P(Y \geq 10) = 1 - P(Y \leq 9) = 1 -$ binomcdf(trials: 12, p: 0.8, x value: 9) = 0.5584. This is the same as $P(X \leq 2)$ because finding 2 or fewer lying is the same as finding 10 or more that are telling the truth.

(b) $\mu_Y = np = 12(0.8) = 9.6$ and $\mu_X = 12(0.20) = 2.4$. This is not surprising because Y = 12 – X so $\mu_Y = 12 - \mu_X = 12 - 9.6 = 2.4$. $\sigma_Y = \sigma_X = \sqrt{12(0.8)(0.2)} = 1.39$. This is not surprising because adding (or subtracting) a constant to a random variable doesn't change the spread.

6.85 (a) Check the BINS: Binary? "Success" = win a prize and "Failure" = don't win a prize. Independent? Assuming that the company puts the caps on in a random fashion, knowing whether one bottle wins or not should not tell us anything about the caps on other bottles. Number? There are n = 7 bottles. Success? The probability of success is p = 1/6 for all bottles. Thus, X is a binomial random variable with n = 7 and p = 1/6.

(b) $\mu_X = np = 7\left(\frac{1}{6}\right) = 1.167$. If we were to buy many sets of 7 bottles, we would get 1.167 winners per set, on average. $\sigma_X = \sqrt{np(1-p)} = \sqrt{7\left(\frac{1}{6}\right)\left(\frac{5}{6}\right)} = 0.986$. If we were to buy many sets of 7 bottles, the number of winning bottles would typically differ from the mean (1.167) by 0.986.

(c) $P(X \geq 3) = 1 - P(X \leq 2) = 1 - \left[\binom{7}{0}\left(\frac{1}{6}\right)^0\left(\frac{5}{6}\right)^7 + \binom{7}{1}\left(\frac{1}{6}\right)^1\left(\frac{5}{6}\right)^6 + \binom{7}{2}\left(\frac{1}{6}\right)^2\left(\frac{5}{6}\right)^5\right] =$ 0.0958. *Using technology*: $P(X \geq 3) = 1 - P(X \leq 2)$ = 1 – binomcdf(trials: 7, *p*: 1/6, *x* value: 2) = 1 – 0.9042 = 0.0958. Because 0.0958 isn't a very small probability, the clerk shouldn't be surprised. It is plausible to get 3 or more winners in a sample of 7 bottles by chance alone.

6.86 (a) Check the BINS: Binary? "Success" = operates for an hour without failure and "Failure" = does not operate for an hour without failure. Independent? Whether one engine operates for an hour or not should not tell us whether any other engine does or not. Number? We are looking at n = 350 engines. Success? Each engine has the same probability of success, p = 0.999. Thus, X is a binomial random variable with n = 350 and p = 0.999.

(b) $\mu_X = np = 350(0.999) = 349.65$. If we were to test many sets of 350 engines, we would expect that about 349.65 of them would operate for an hour without failure, on average. $\sigma_X = \sqrt{np(1-p)} = \sqrt{350(0.999)(0.001)} = 0.591$. If we were to test many sets of 350 engines, we would expect the number that operate for an hour without failure to typically vary by about 0.591 from the mean (349.65).

(c) $P(X \leq 348) = 1 - P(X = 349) - P(X = 350)$

$= 1 - \binom{350}{349}(0.999)^{349}(0.001)^1 - \binom{350}{350}(0.999)^{350}(0.001)^0 = 1 - 0.2468 - 0.7046 = 0.0486$. Using technology, $P(X \leq 348)$ = binomcdf(trials: 350, *p*: 0.999, *x* value: 348) = 0.0486. There is less than a 5% chance that 2 or more engines will fail if the probability of performing properly for an hour of flight is 0.999. Because this is a small probability, there is convincing evidence that the engines are less reliable than they are supposed to be.

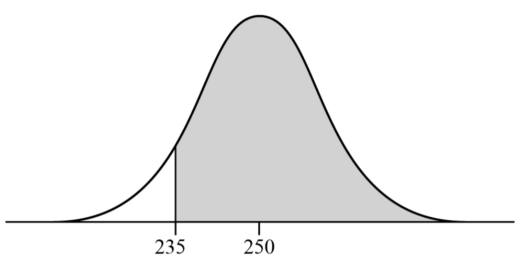
6.87 No. Because we are sampling without replacement and the sample size (10) is more than 10% of the population size (76), we should not treat the observations as independent.

6.88 Yes. We can use the binomial distribution in this case because the sample size (7) is less than 10% of the population size (100). Even though the make-up of the population will change somewhat with each tile drawn, the probabilities computed using the binomial distribution will be approximately correct.

6.89 To have a binomial setting, the trials must be independent. When sampling without replacement, the trials are not independent because knowing the outcomes of previous trials makes it easier to predict what will happen in future trials. However, if the sample is a small fraction of the population (less than 10%), the make-up of the population doesn't change enough to make the lack of independence an issue.

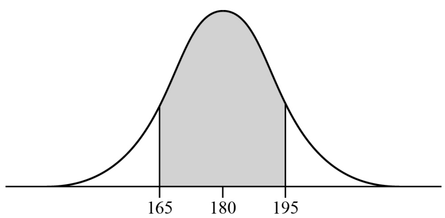
6.90 When we look at the histogram for a binomial distribution, it is symmetric when $p = 0.5$. As p moves farther from 0.5, the probability distribution for a fixed n becomes more skewed. However, if we fix a p (not 0.5) and increase n, the distribution becomes less skewed. So we need a criterion that takes both n and p into consideration. When $np \geq 10$ and $n(1-p) \geq 10$ then we know that the combination of n and p is such that the binomial distribution is close enough to Normal to use the Normal approximation.

6.91 (a) Check the BINS: Binary? "Success" = visit an auction site at least once a month and "Failure" = don't visit an auction site at least once a month. Independent? We are sampling without replacement, but the sample size (500) is far less than 10% of all males aged 18 to 34 so we can assume independence. Number? $n = 500$ men. Success? The probability of success for each individual is $p = 0.50$. Thus, X is approximately a binomial random variable with $n = 500$ and $p = 0.50$.
(b) $np = 500(0.5) = 250$ and $n(1-p) = 500(0.5) = 250$ are both at least 10, so it is reasonable to use the Normal approximation.
(c) **Step 1: State the distribution and values of interest.** $\mu_X = np = 500(0.5) = 250$ and $\sigma_x = \sqrt{np(1-p)} = \sqrt{500(0.5)(0.5)} = 11.18$. Thus X has approximately the $N(250, 11.18)$ distribution. We want to find $P(X \geq 235)$ as shown below. **Step 2: Perform calculations. Show your work.** The standardized score for the boundary value is $z = \dfrac{235-250}{11.18} = -1.34$. The desired probability is $P(Z \geq -1.34) = 0.9099$. *Using technology:* The command normalcdf(lower: 235, upper: 1000, μ: 250, σ: 11.18) gives an area of 0.9102. **Step 3: Answer the question.** There is a 0.9102 probability that at least 235 of the men in the sample visit an online auction site.



6.92 (a) Check the BINS: Binary? "Success" = Person identifies themself as black and "Failure" = person does not identify themself as black. Independent? We are sampling without replacement, but the sample size (1500) is far less than 10% of all American adults. Number? $n = 1500$ people were sampled. Success? The probability of success for any one individual is $p = 0.12$. Thus, X is approximately a binomial random variable with $n = 1500$ and $p = 0.12$.
(b) The Normal approximation is quite safe: $np = 1500(0.12) = 180$ and $n(1-p) = 1500(0.88) = 1320$ are both at least 10.

(c) **Step 1: State the distribution and values of interest.** $\mu_X = np = 1500(0.12) = 180$ and $\sigma_X = \sqrt{1500(0.12)(0.88)} = 12.5857$. Thus, X has approximately the $N(180, 12.5857)$ distribution. We want to find $P(165 \le X \le 195)$ as shown below. **Step 2: Perform calculations. Show your work.** The standardized scores for the boundary values are $z = \frac{165-180}{12.5857} = -1.19$ and $z = \frac{195-180}{12.5857} = 1.19$. The desired probability is $P(-1.19 \le Z \le 1.19) = P(Z \le 1.19) - P(Z \le -1.19) = 0.8830 - 0.1170 = 0.7660$. *Using technology*: The command normalcdf(lower: 165, upper: 195, μ: 180, σ: 12.5857) gives an area of 0.7667. **Step 3: Answer the question.** There is a 0.7667 probability that the sample will contain between 165 and 195 blacks.



6.93 Let X be the number of 1's and 2's. Then X has a binomial distribution with $n = 90$ and $p = 0.477$ (in the absence of fraud).

$P(X \le 29) = \binom{90}{0}(0.477)^0(0.523)^{90} + \cdots + \binom{90}{29}(0.477)^{29}(0.523)^{61} = 0.0021$. *Using technology*: binomcdf(90, 0.477, 29) = 0.0021. Using the Normal approximation (the conditions are satisfied), we find a mean of $\mu_X = np = 90(0.477) = 42.93$

and standard deviation of $\sigma_X = \sqrt{90(0.477)(0.523)} = 4.7384$. The standardized score for the boundary value is $z = \frac{29-42.93}{4.7384} = -2.94$ and the desired probability is $P(Z \le -2.94) = 0.0016$. Because the probability of getting 29 or fewer invoices that begin with the digits 1 or 2 is quite small, we have reason to be suspicious that the invoice amounts are not genuine.

6.94 Let X be the number of hits out of 500 times at bat. Then X has a binomial distribution with $n = 500$ and $p = 0.260$. We want to know the probability of hitting at least 0.300 in 500 at-bats, which is equivalent to getting at least 150 hits. $P(X \ge 150) = \binom{500}{150}(0.260)^{150}(0.740)^{350} + \cdots + \binom{500}{500}(0.260)^{500}(0.740)^0 = 0.0246$. *Using technology*: 1 – binomcdf(trials: 500, *p*: 0.260, *x* value: 149) = 1 – 0.9754 = 0.0246. Using the Normal approximation (the conditions are satisfied), we find a mean of $\mu_X = np = 500(0.260) = 130$ and a standard deviation of $\sigma_X = \sqrt{500(0.26)(0.74)} = 9.808$. The standardized score for the boundary value is $z = \frac{150-130}{9.808} = 2.04$ and the desired probability is $P(Z \ge 2.04) = 1 - 0.9793 = 0.0207$. Because this probability is fairly small, it is unlikely for a 0.260 hitter to hit 0.300 just by chance. However, if there are a large number of 0.260 hitters, we would expect about 2% of them to hit 0.300 or higher just by chance. So yes, a Major Leaguer *could* hit 0.300 just by chance.

6.95 (a) This is not a geometric setting because we can't classify the possible outcomes on each trial (card) as "success" or "failure" and we are not selecting cards until we get 1 success—we are selecting cards until we get one of each type.
(b) Games of 4-Spot Keno are independent, the probability of winning is the same in each game (p = 0.259), and Lola is repeating a chance process until she gets a success. This is a geometric setting and X = number of games needed to win once is a geometric random variable with p = 0.259.

6.96 (a) This is not a geometric setting because trials are not independent. Because we are selecting cards without replacement, knowing the outcomes of previous trials helps us predict the outcomes of future trials.
(b) Assuming his shots are independent, this is a geometric setting because the probability of success is the same for each shot (p = 0.10) and he continues to shoot until he gets a bull's-eye. X = number of shots needed to get a bull's-eye is a geometric random variable with p = 0.10.

6.97 (a) Let X = the number of bottles Alan purchases to find one winner. X is a geometric random variable with p = 1/6. $P(X=5)=\left(\frac{5}{6}\right)^4\left(\frac{1}{6}\right)=0.0804$. *Using technology:* geometpdf(p: 1/6, x value: 5) = 0.0804. There is a 0.0804 probability that he buys exactly 5 bottles.
(b) $P(X \le 8)=P(X=1)+\ldots+P(X=8)=\left(\frac{1}{6}\right)+\ldots+\left(\frac{5}{6}\right)^7\left(\frac{1}{6}\right)=0.7674$. *Using technology:* geometcdf(p: 1/6, x value: 8) = 0.7674. There is a 0.7674 probability that he buys no more than 8 bottles.

6.98 (a) Let X = the number of pulls that Rita needs to start the lawn mower. X is a geometric random variable with p = 0.20. $P(X=3)=(0.8)^2(0.2)=0.128$. *Using technology:* geometpdf(p: 0.20, x value: 3) = 0.128. There is a 0.128 probability that it takes Rita exactly 3 pulls to start the mower.
(b) $P(X > 10) = 1 - P(X \le 10) = 1 - (0.20) - \ldots - (0.8)^9(0.20) = 0.1074$. *Using technology*: 1 – geometcdf(p: 0.20, x value: 10) = 1 – 0.8926 = 0.1074. There is a 0.1074 probability that it takes Rita more than 10 pulls to start the mower.

6.99 (a) X = number of invoices needed to find one that begins with an 8 or 9 is a geometric random variable with p = 0.097. The expected value is $\mu_X=\frac{1}{p}=\frac{1}{0.097}=10.31$. We would expect to examine about 10.31 invoices in order to find the first 8 or 9.
(b) *Using technology*: $P(X \ge 40) = 1 - P(X \le 39)$ = 1 – geometcdf(p: 0.097, x value: 39) = 1 – 0.9813 = 0.0187. Because the probability of not getting an 8 or 9 before the 40th invoice is small, we may begin to worry that the invoice amounts are a fraud.

6.100 (a) X = number of spins needed for the ball to land in the 15 slot is a geometric random variable with p = 1/38. The expected value is $\mu_X=\frac{1}{p}=\frac{1}{\frac{1}{38}}=38$. We would expect it to take about 38 games for the ball to land in the 15 slot.

(b) $P(X \le 3) = \left(\frac{1}{38}\right) + \left(\frac{37}{38}\right)^1 \left(\frac{1}{38}\right) + \left(\frac{37}{38}\right)^2 \left(\frac{1}{38}\right) = 0.0769$. *Using technology*: geometcdf(*p*: 1/38, *x* value: 3) = 0.0769. Because the probability is not that small, I wouldn't be surprised if Marti won in 3 or fewer spins.

6.101 b

6.102 c

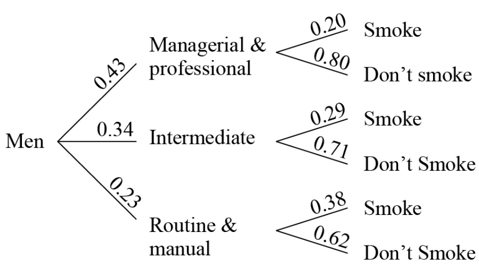
6.103 d

6.104 d

6.105 c

6.106 This is an experiment because a treatment was deliberately imposed on the students, randomly assigned at the time they visited the site. The explanatory variable is the type of login box (genuine or not), and the response variable is the student's action (logging in or not).

6.107 (a)



$P(\text{smoke}) = 0.43(0.20) + 0.34(0.29) + 0.23(0.38) = 0.086 + 0.0986 + 0.0874 = 0.272$. 27.2% of British men smoke.

(b)

$$P(\text{routine and manual} \mid \text{smoke}) = \frac{P(\text{routine and manual and smoke})}{P(\text{smoke})} = \frac{0.23(0.38)}{0.272} = \frac{0.0874}{0.272} = 0.321.$$

About 32% of the smokers are routine and manual laborers.